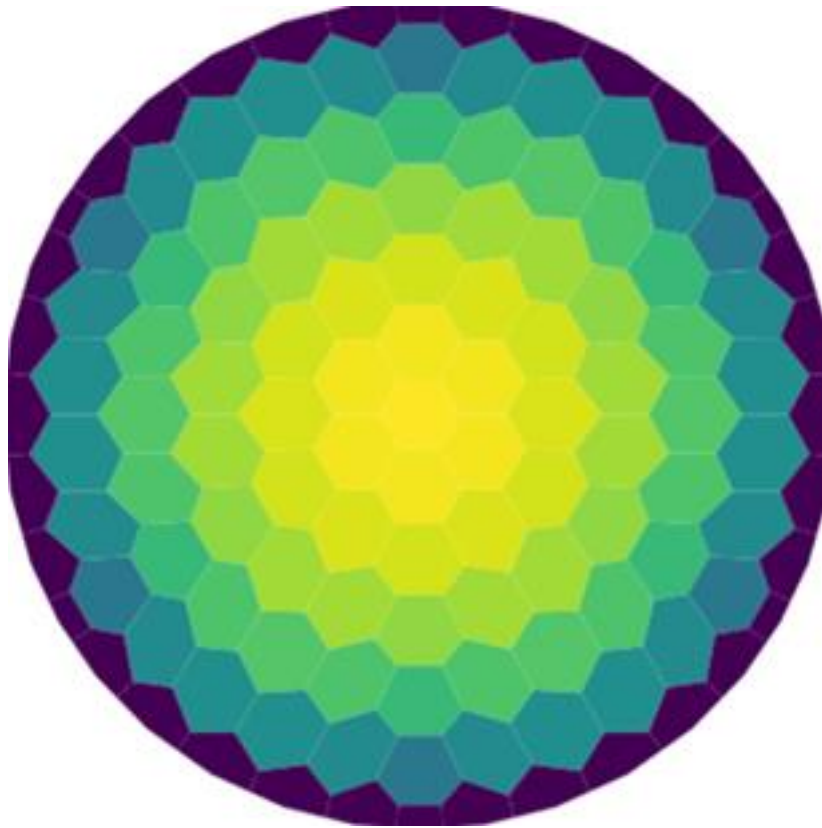


Deltares



Unstructured grids, MODFLOW6,
imod-python

Huite Bootsma

Package overzicht

Maak een
ungestructureerd
grid



Deze packages worden door iMOD-Python gebruikt, maar zijn ook direct te gebruiken.

Zet de data erop,
herschaaal
("IDFSCALE")



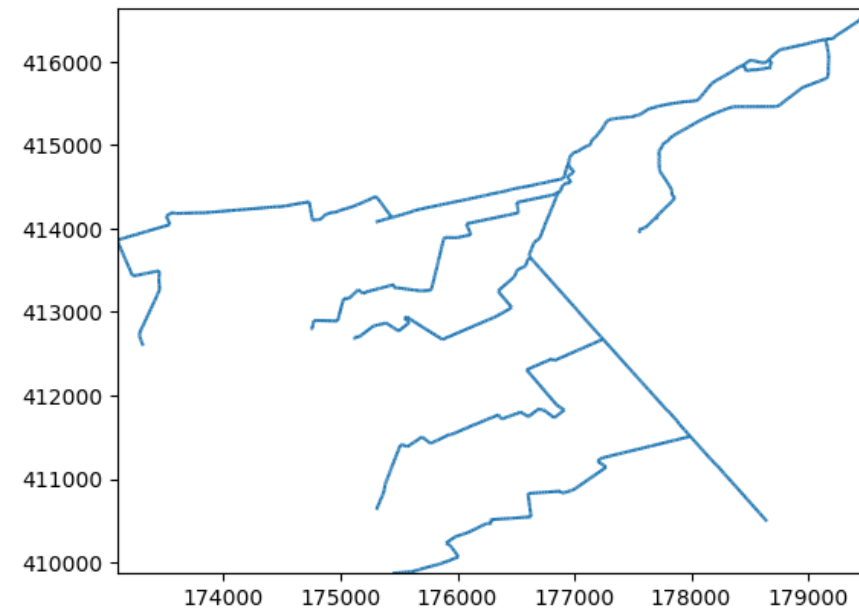
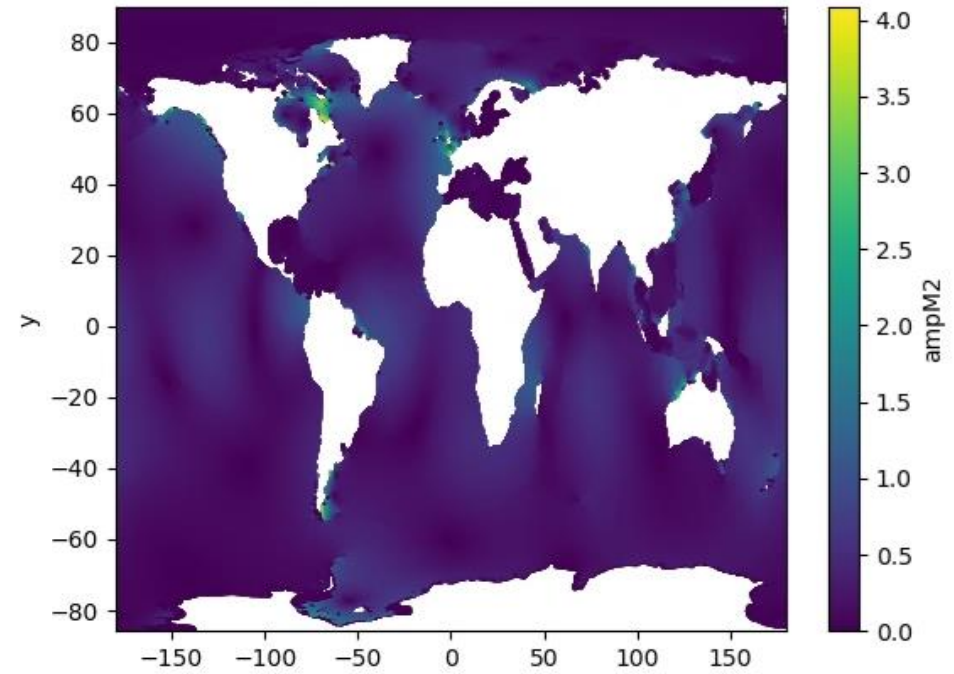
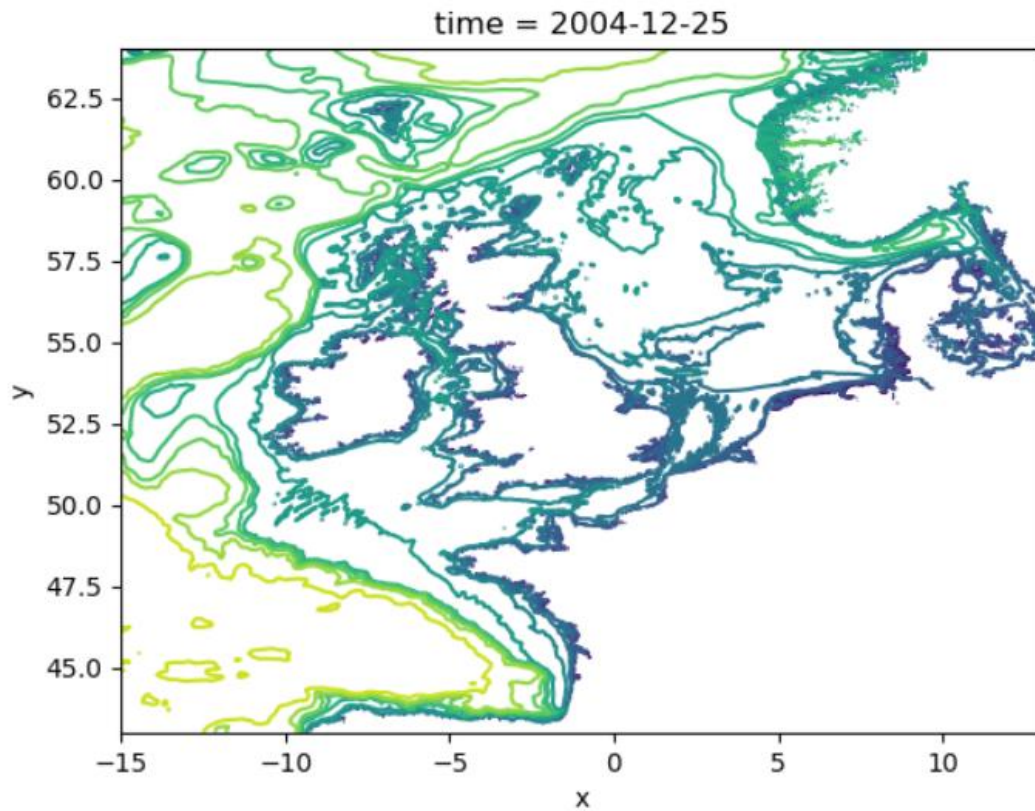
Worden afzonderlijk gehouden, ze dienen namelijk een algemener doel dan MODFLOW 6!

Schrijf en lees
MODFLOW 6
bestanden



Algemener doel

Bijv. D-HYDRO/DFM



Deltares

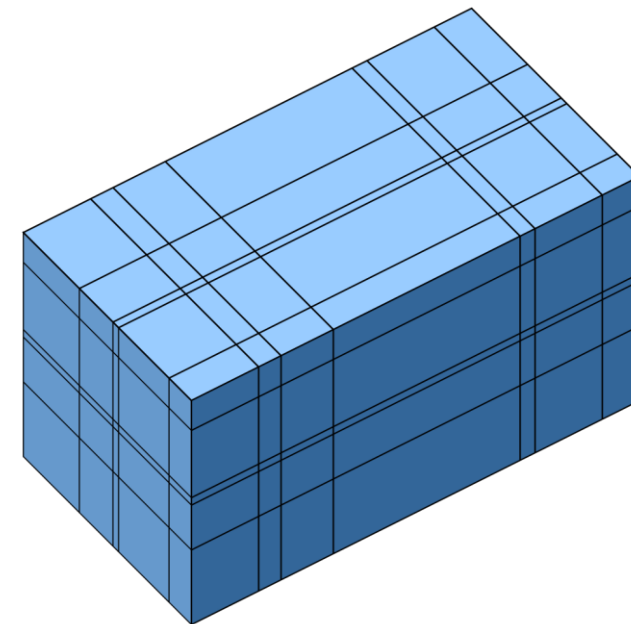
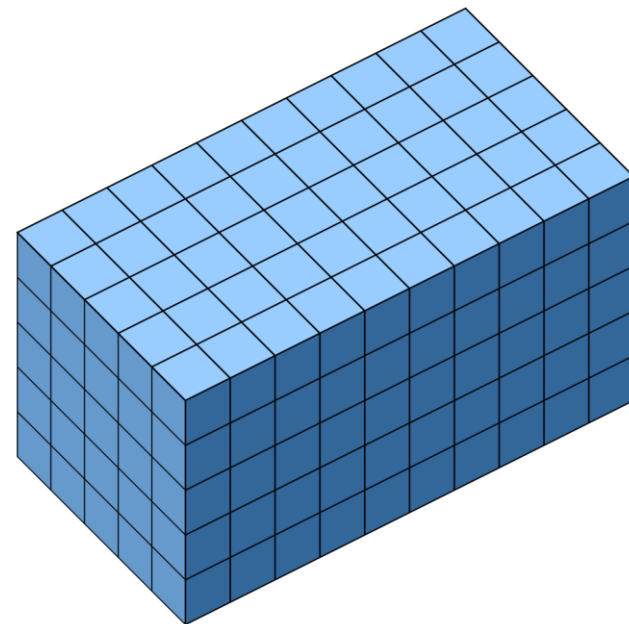
Voordelen van ongestructureerd

Directere vertegenwoordiging van hydrologische kenmerken

Flexibel qua verfijning: het uiteindelijke doel is efficiëntie

Welke vorm (quadtree/octree, voronoi, driehoeken) het beste werkt, moet nog blijken!

— Maar het gereedschap is zo langzamerhand ver genoeg om te testen



Grid generatie

pandamesh



```
import geopandas
import pandamesh
```

```
geodataframe = geopandas.read_file("netherlands.shp")
```

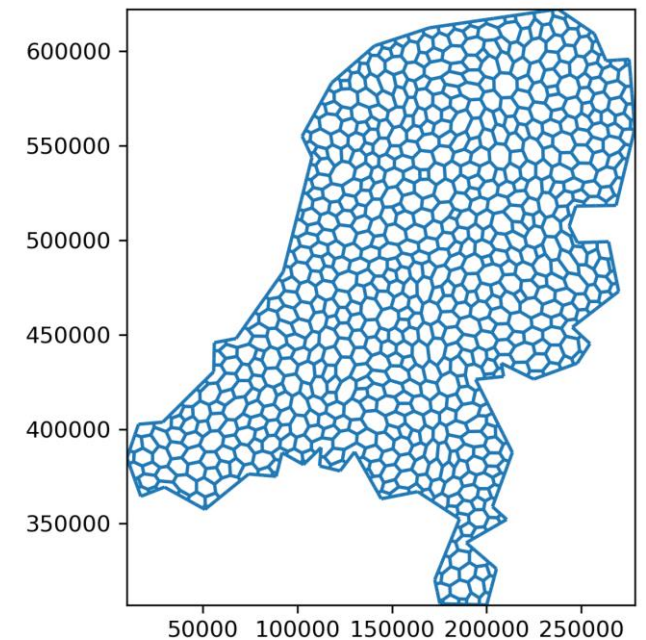
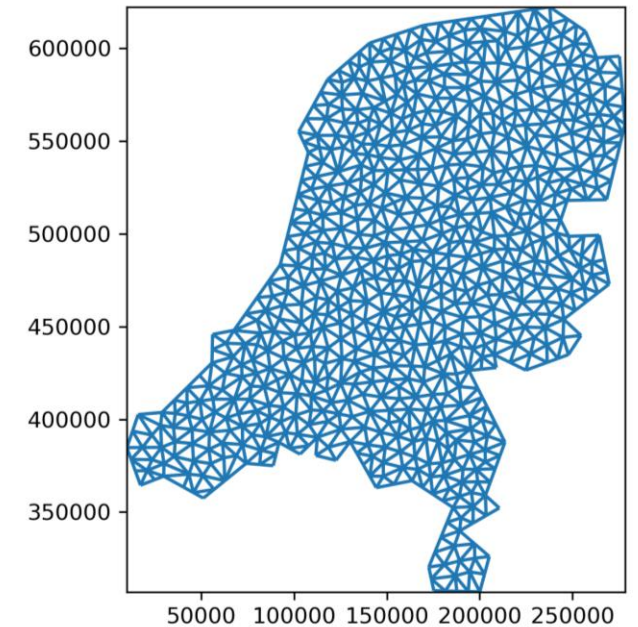
```
mesher = pandamesh.TriangleMesher(geodataframe)
```

```
triangle_grid = mesher.generate_ugrid()
```

```
voronoi_grid = triangle_grid.tesselate_centroidal_voronoi()
```

De TriangleMesher is relatief snel:
Nederland met ~250 m driehoeken (2.1 miljoen
cellen) is circa 1.25 seconds

(QuadTree generatie: komt nog)



Xugrid



De volgende taken zijn aanzienlijk lastiger bij ongestructureerde grids

- Cellen vinden op basis van locatie
- Intersecties met geometrieën
- Cel-naar-cel verbindingen

Xugrid maakt het makkelijk(er)!

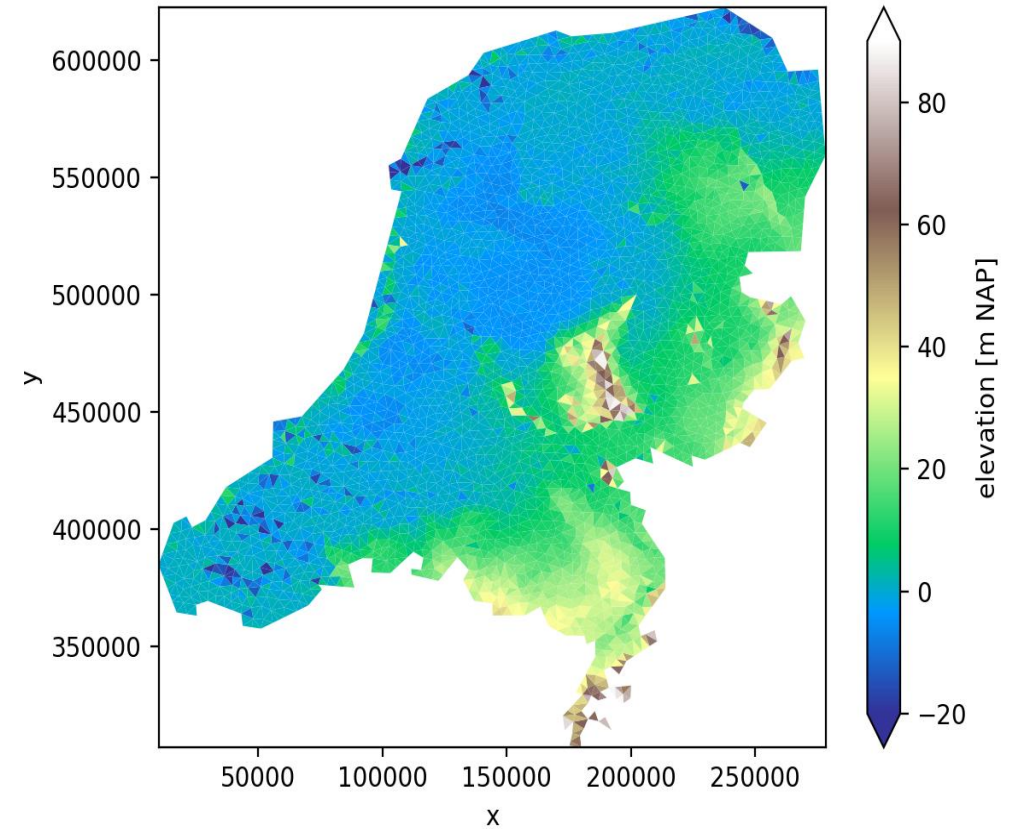
Xugrid: selectie

Xugrid



Volledige dataset

```
uda.ugrid.plot(  
    ax=ax0, vmin=-20, vmax=90, cmap="terrain"  
)
```

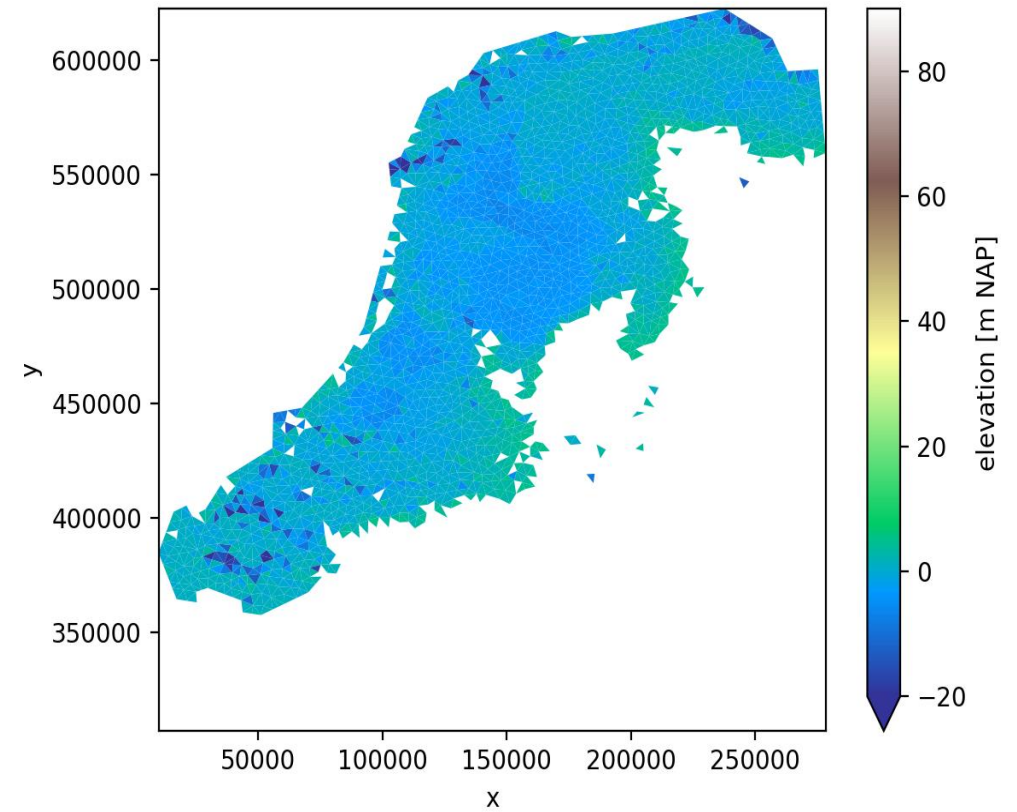


Xugrid: selectie

Xugrid



```
below_5 = elevation.where(  
    elevation < 5.0  
)
```

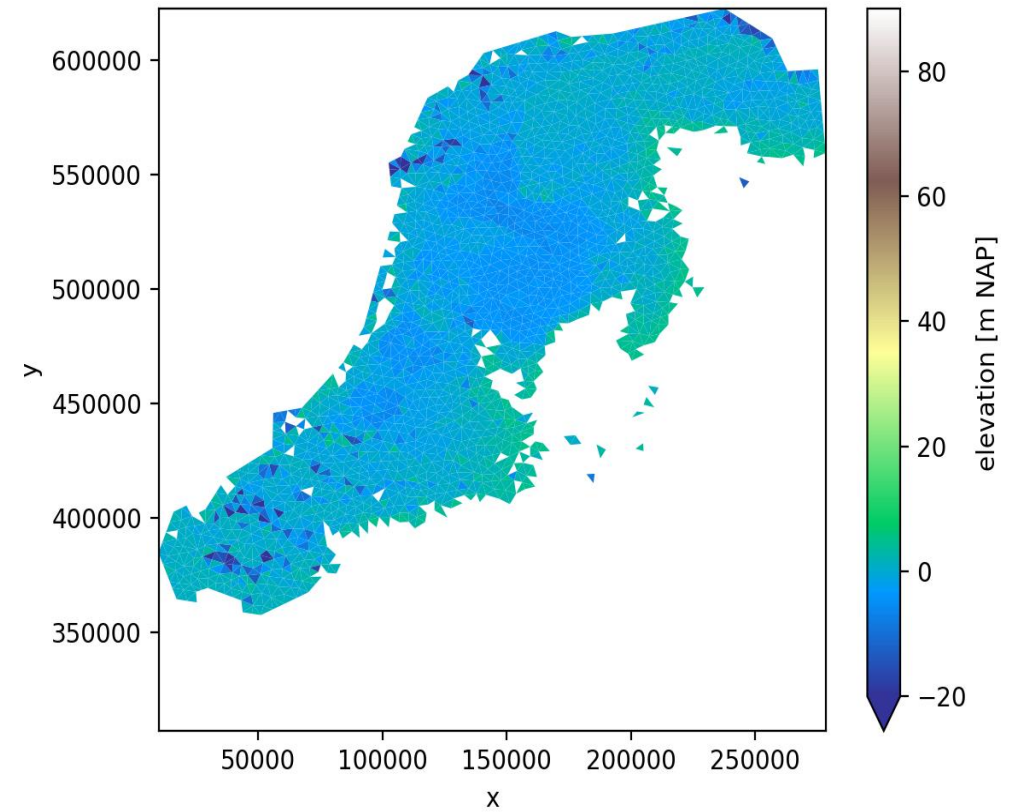


Xugrid: selectie

Xugrid



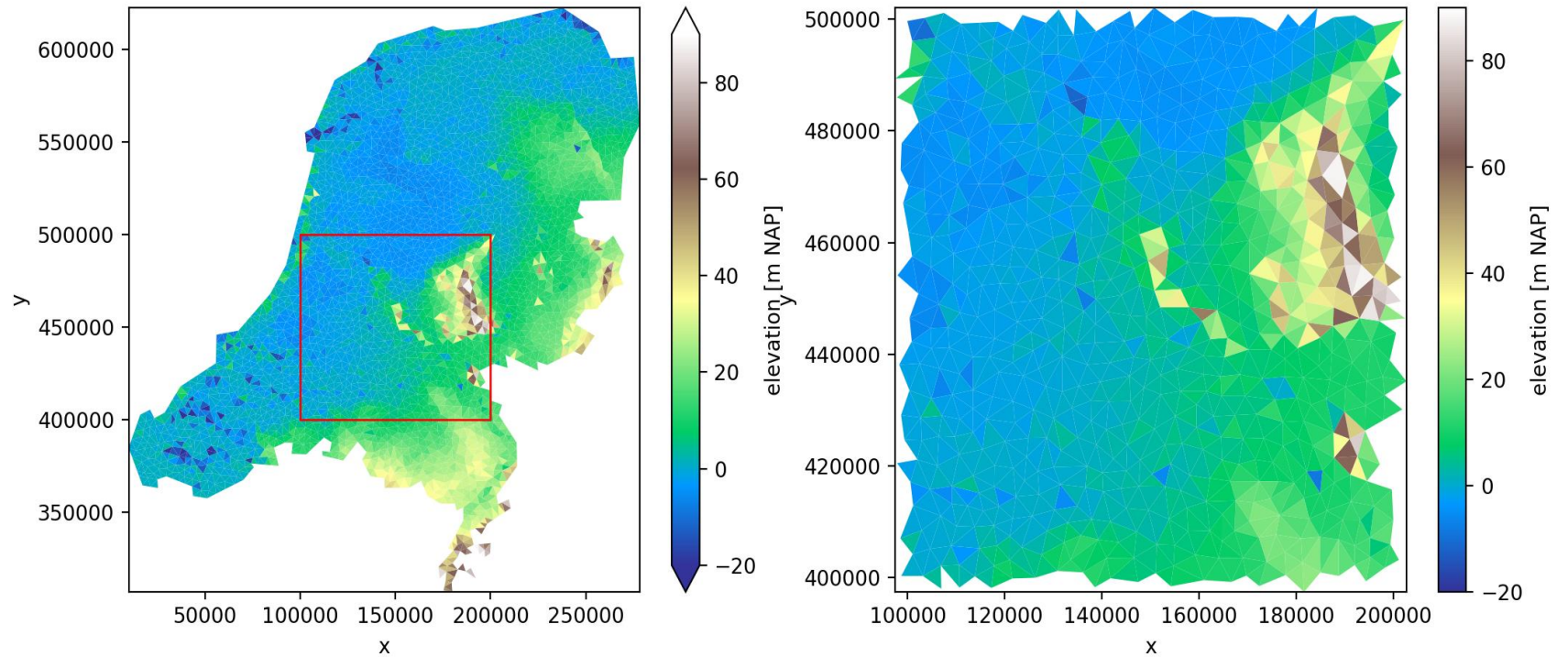
```
below_5 = elevation.where(  
    elevation < 5.0  
)
```



Xugrid: selectie



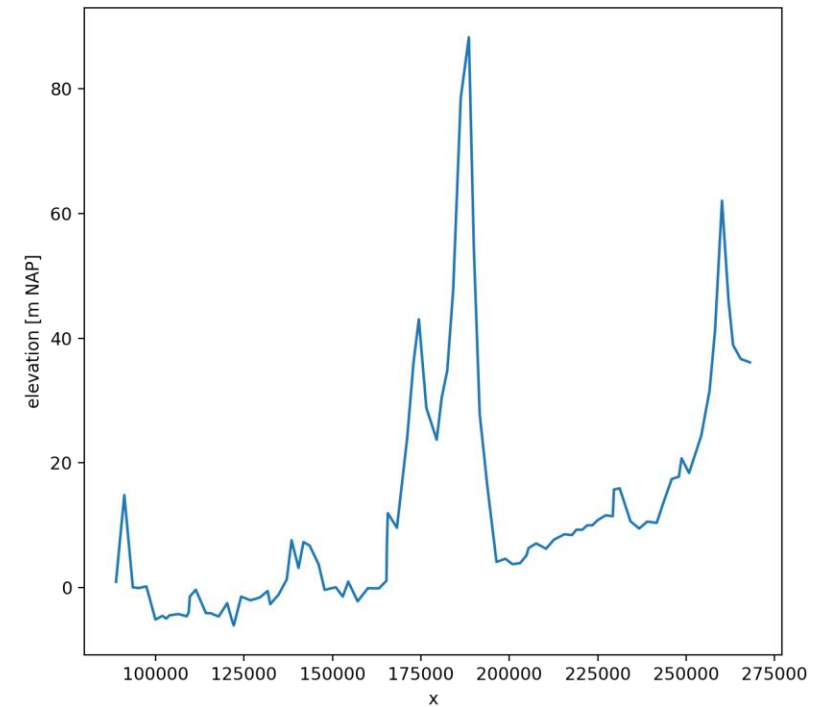
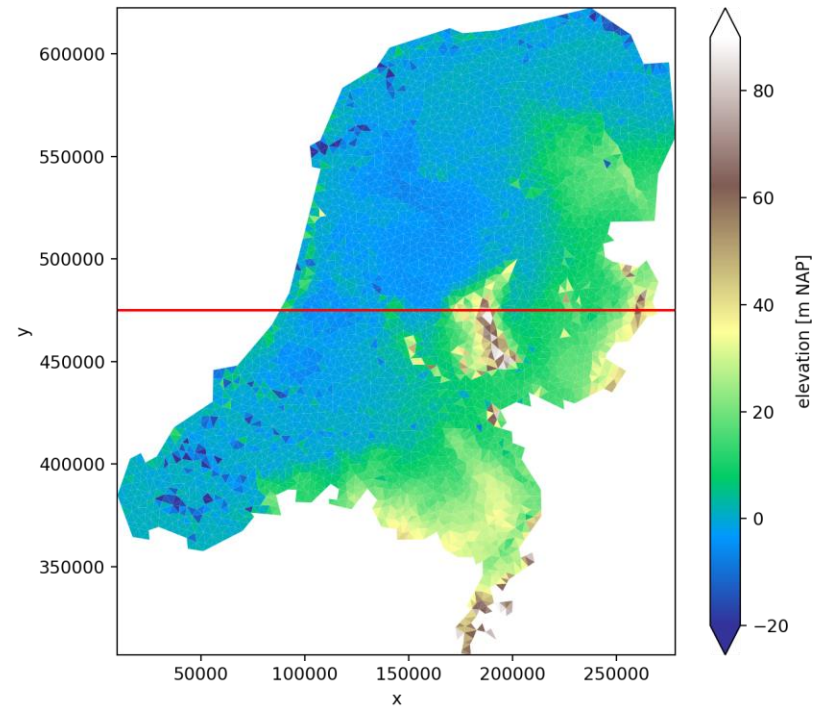
```
selection = uda.ugrid.sel(  
    x=slice(100_000.0, 200_000.0),  
    y=slice(400_000.0, 500_000.0),  
)
```



Xugrid: selectie



```
section = uda.ugrid.sel(y=475_000.0)
```



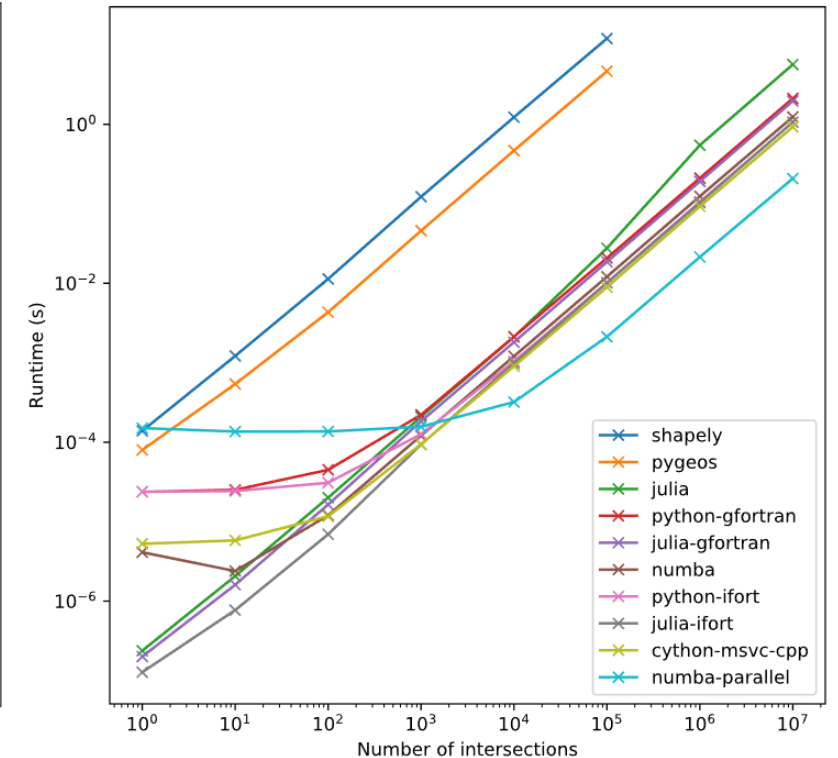
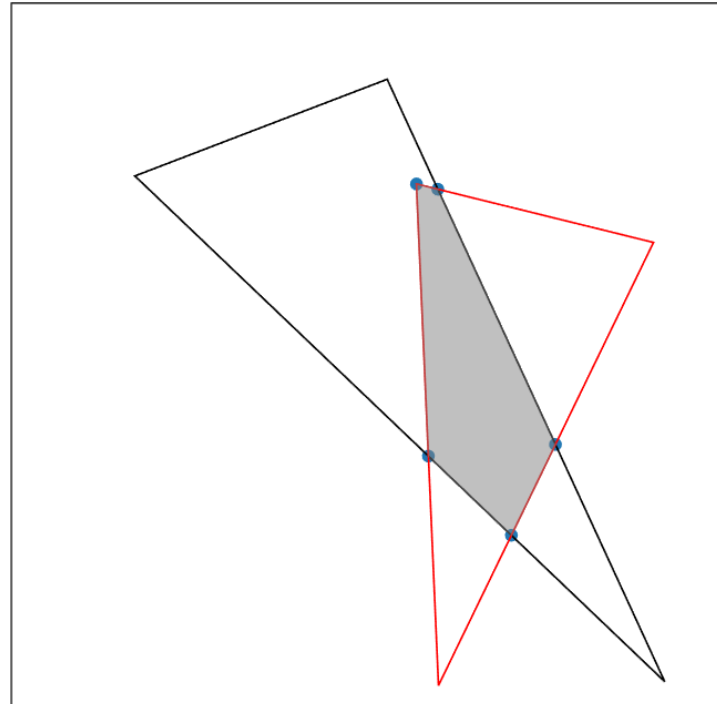
Xugrid: intersectie performance



Makkelijkste wijze van
intersecties berekenen is met
GIS routines (shapely / pygeos)

Maar meer dan 500 (!) times
langzamer dan een
gespecialiseerde implementatie

Python implementatie in xugrid
is even snel als Fortran / C++



Xugrid: intersectie performance

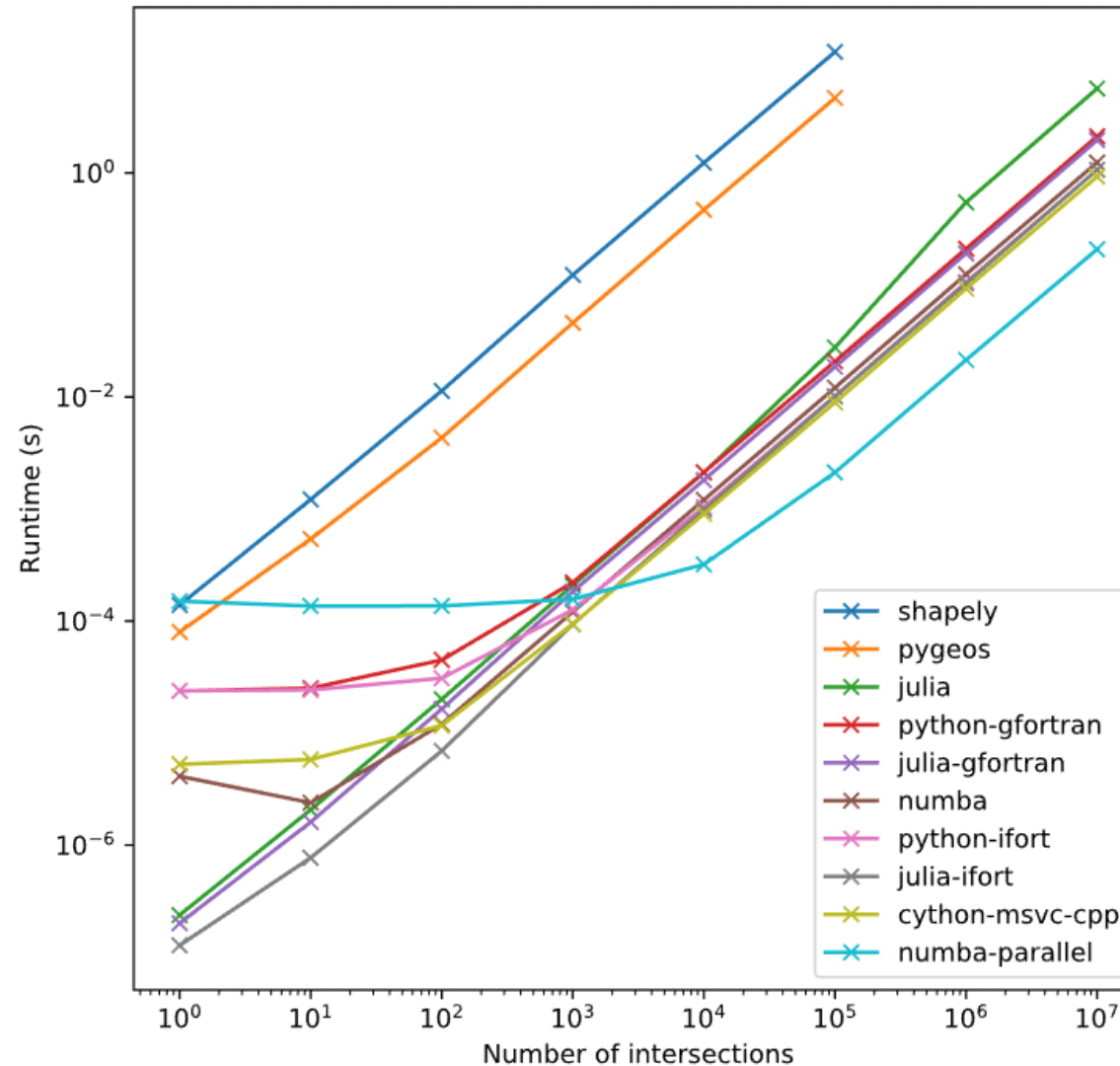
Xugrid



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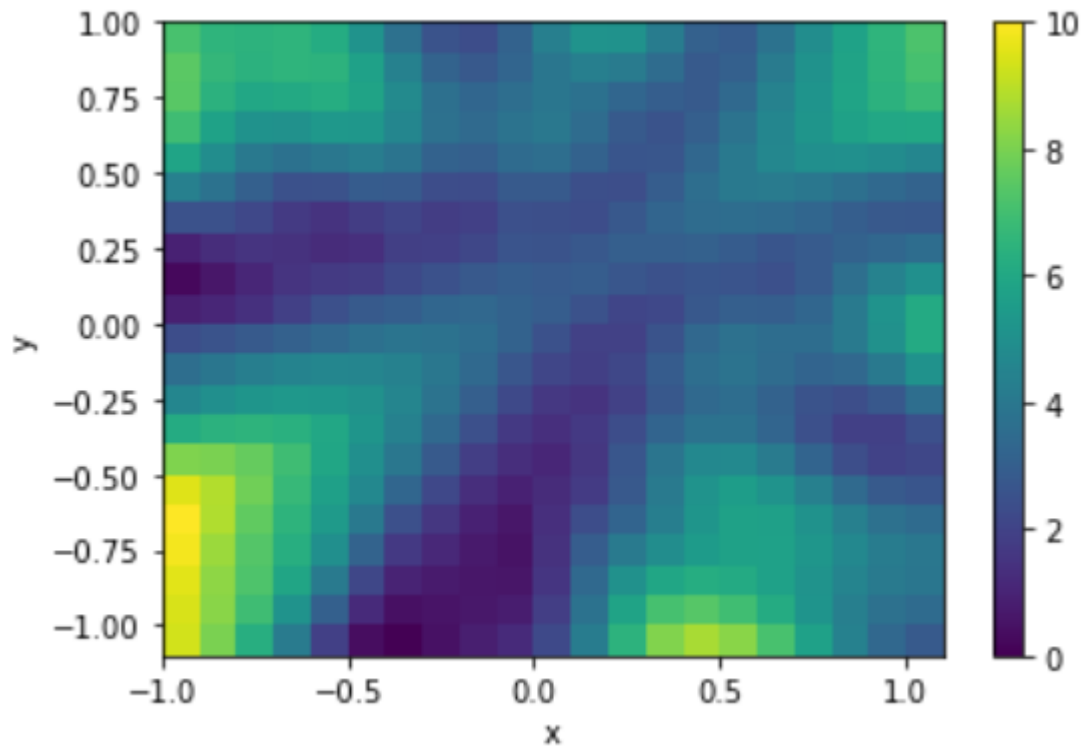


Xarray vs Xugrid

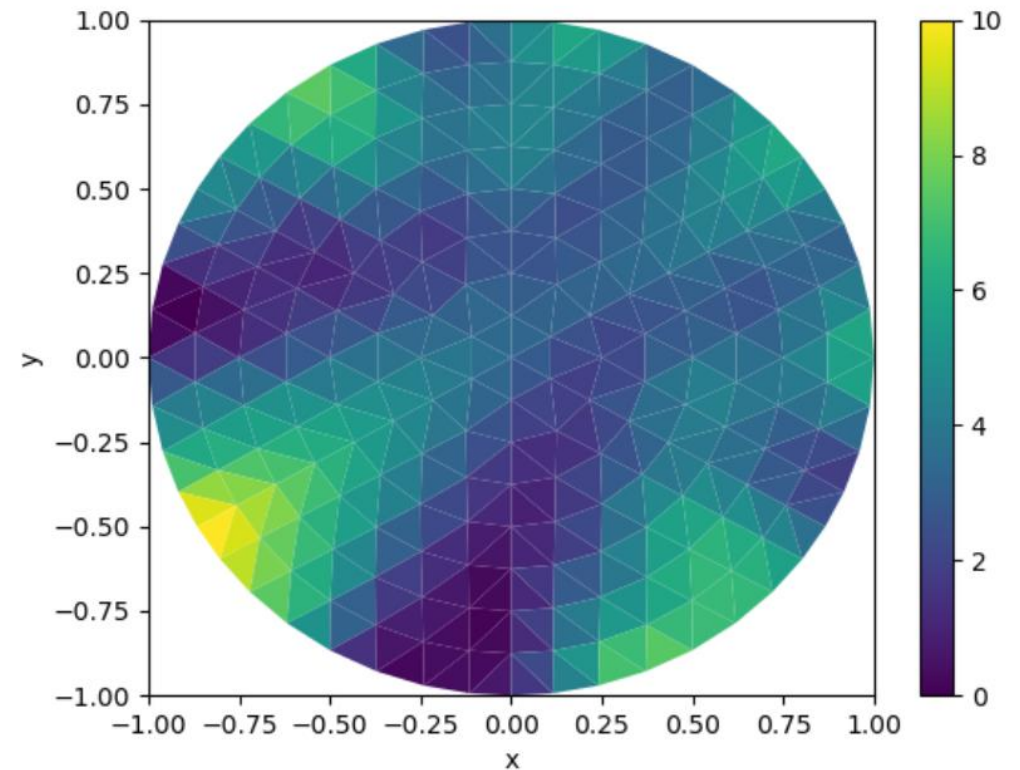
Xugrid



`structured.plot()`



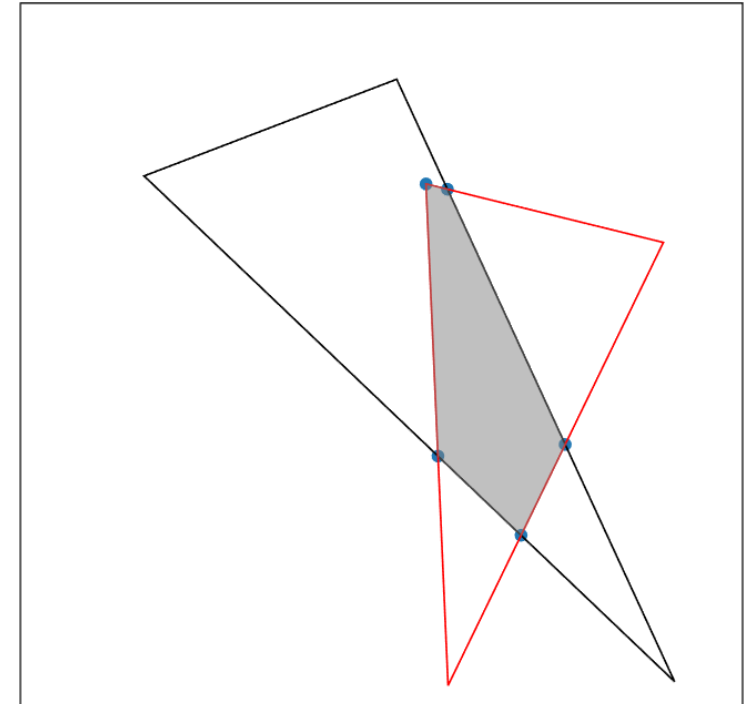
`unstructured.ugrid.plot()`



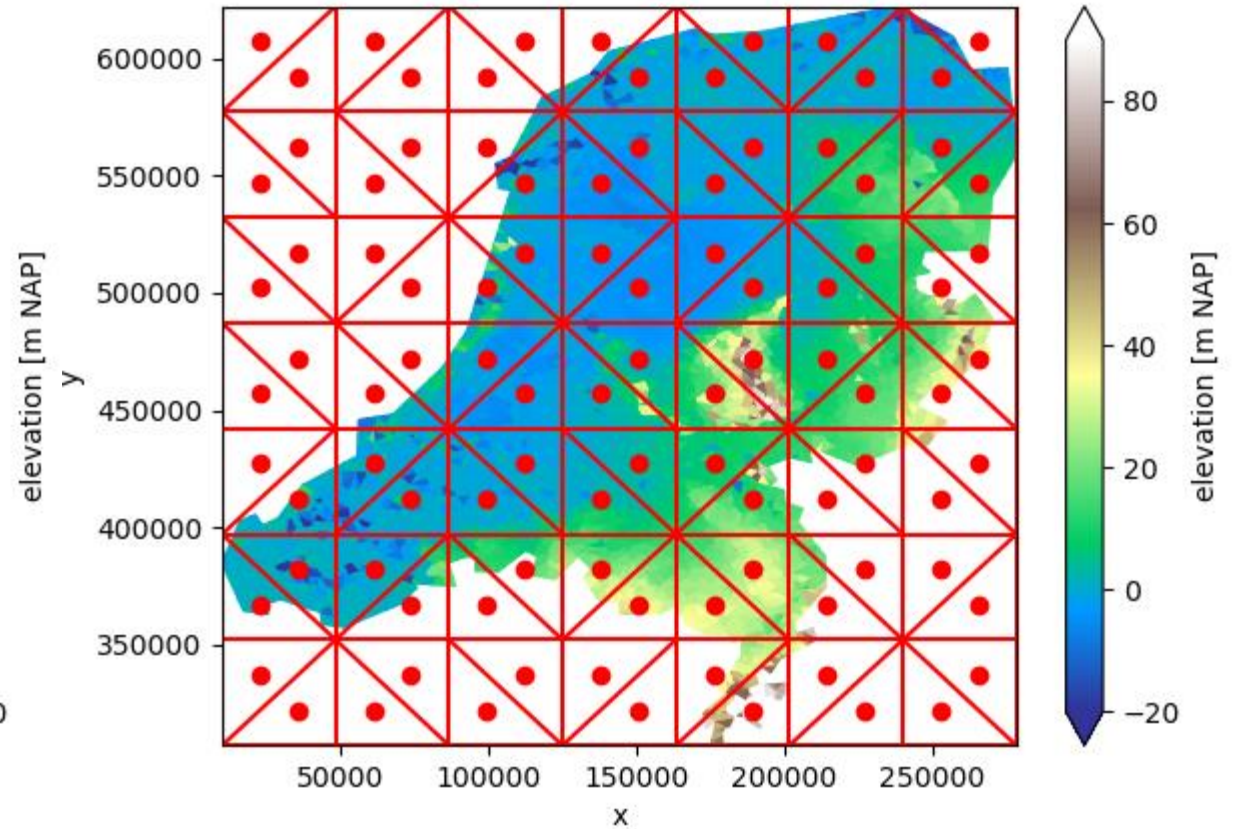
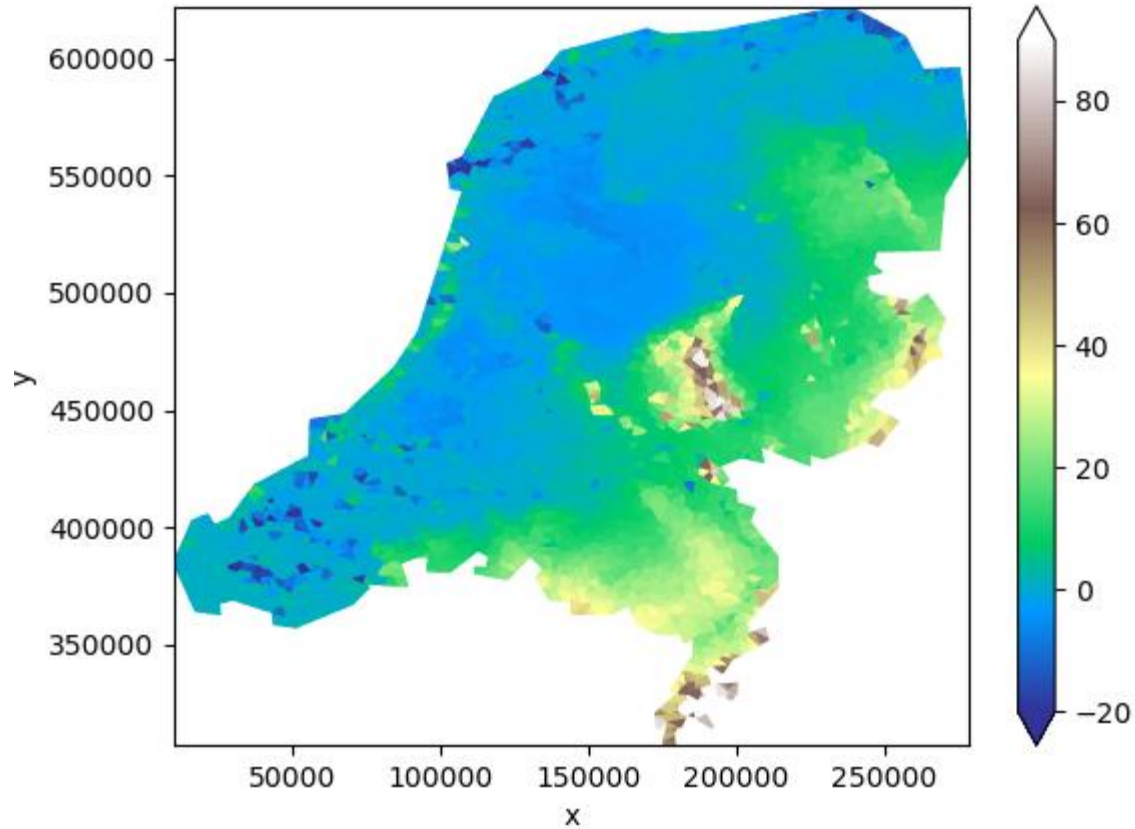
Regridding

Meerdere methodes van regridding, meestal gebiedsgewogen:

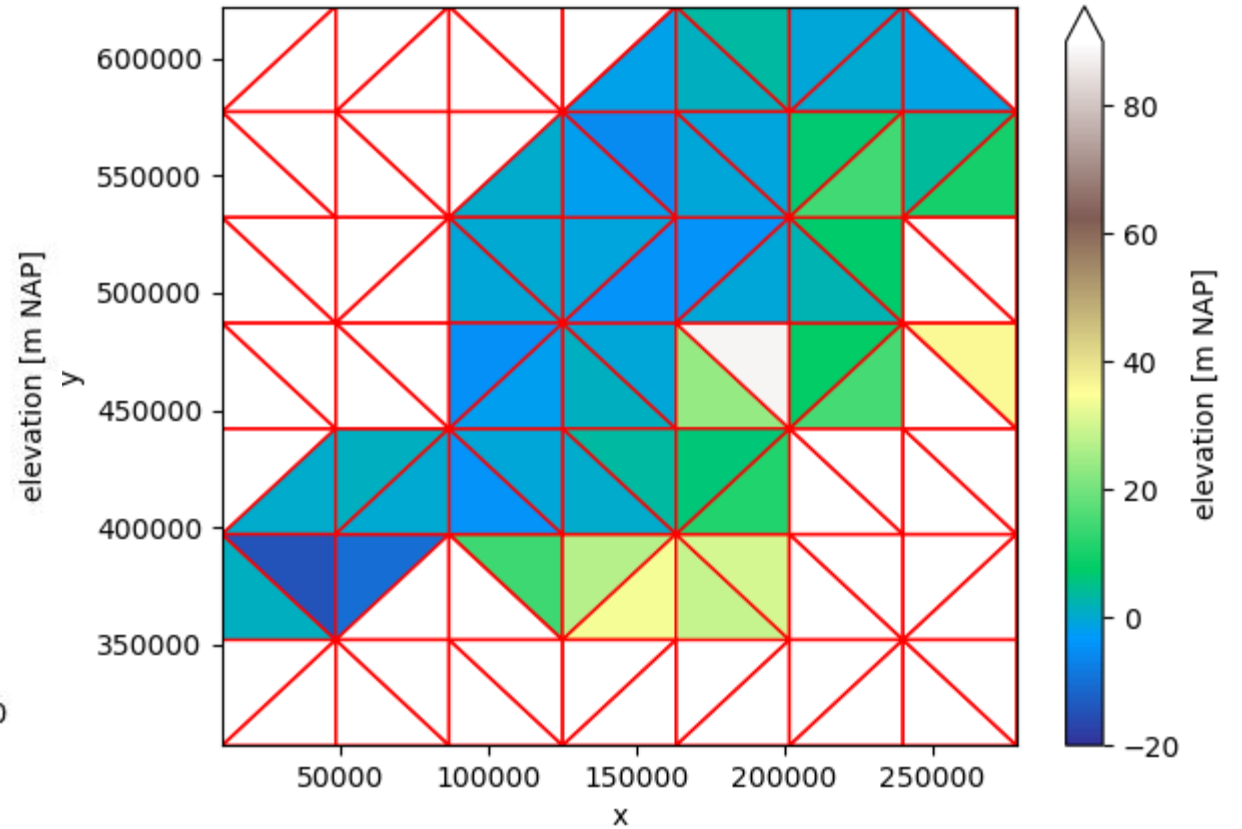
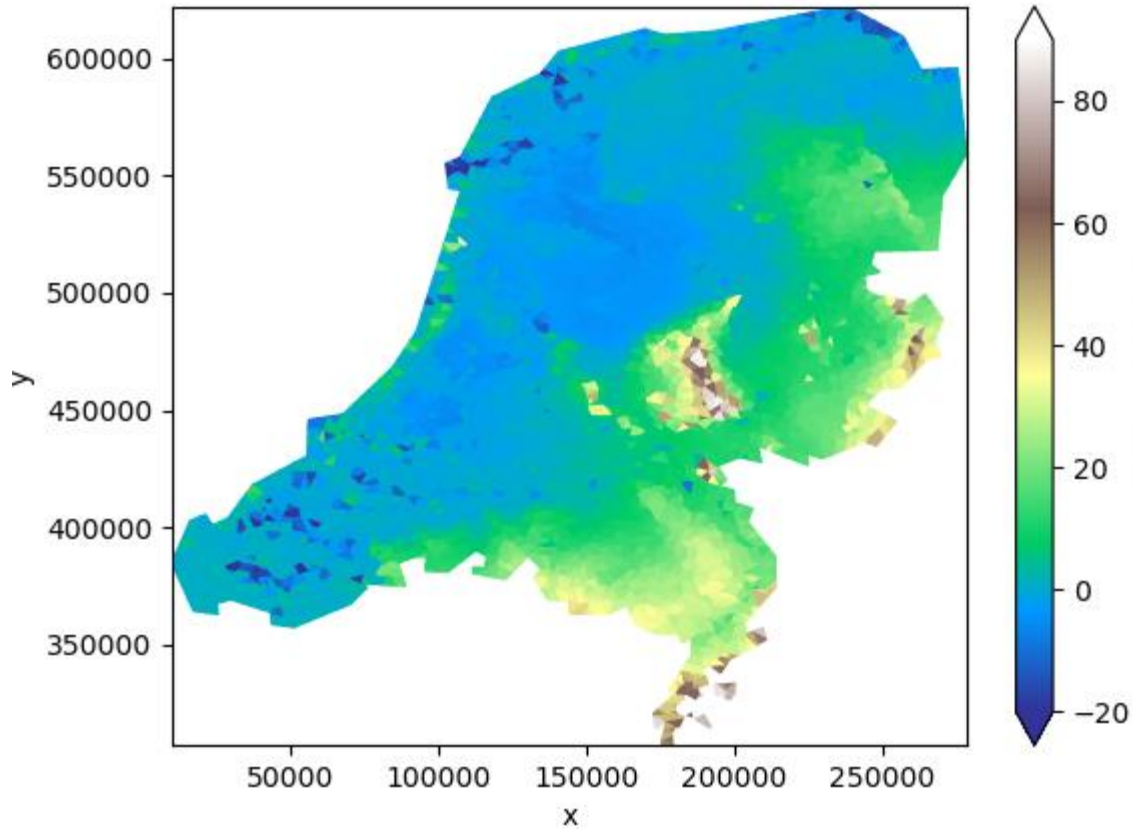
- gemiddelde (stijghoogte, waterhoogtes)
- harmonisch gemiddelde (verticale doorlatendheid)
- Geometrisch gemiddelde (horizontale doorlatendheid)
- maximum
- minimum
- maximum overlap
- percentiel (hoogte voor maaiveld-afstroming)
- conductance (eerste-orde conservatief)



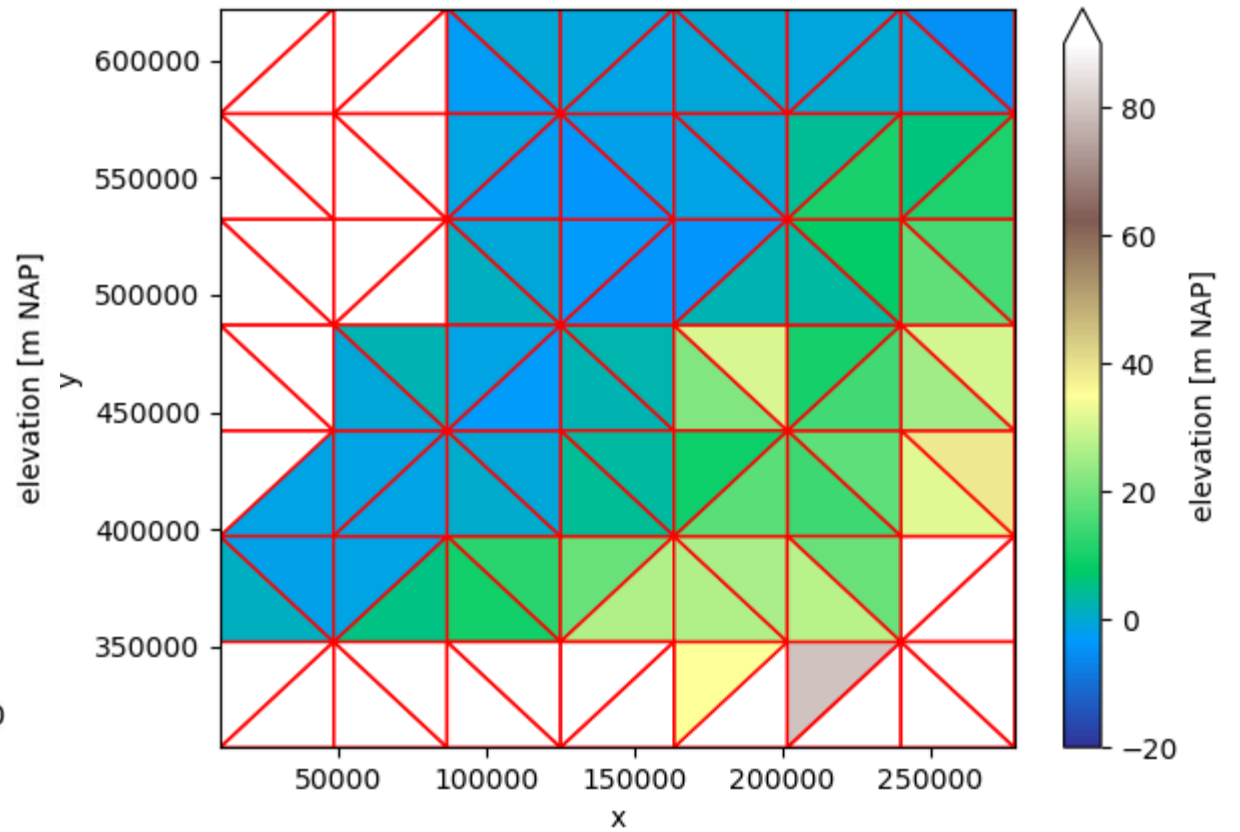
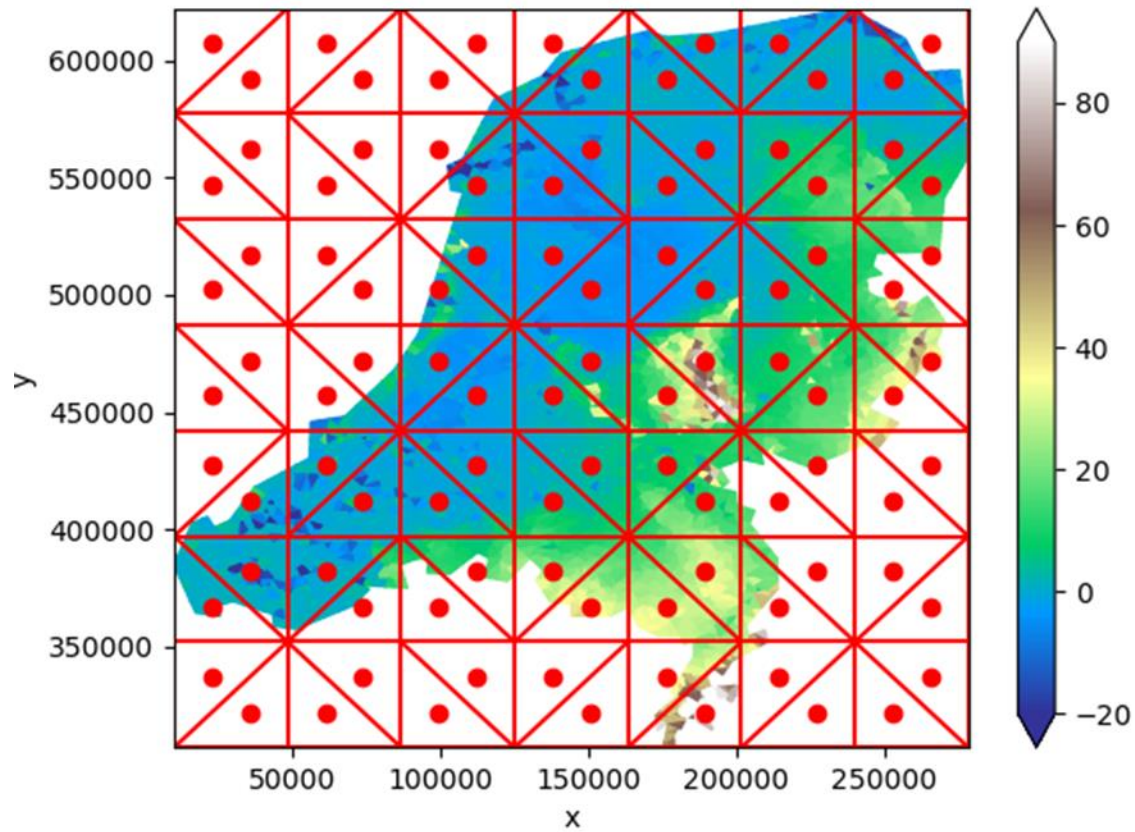
Regridding: CentroidLocator (“prikken”)



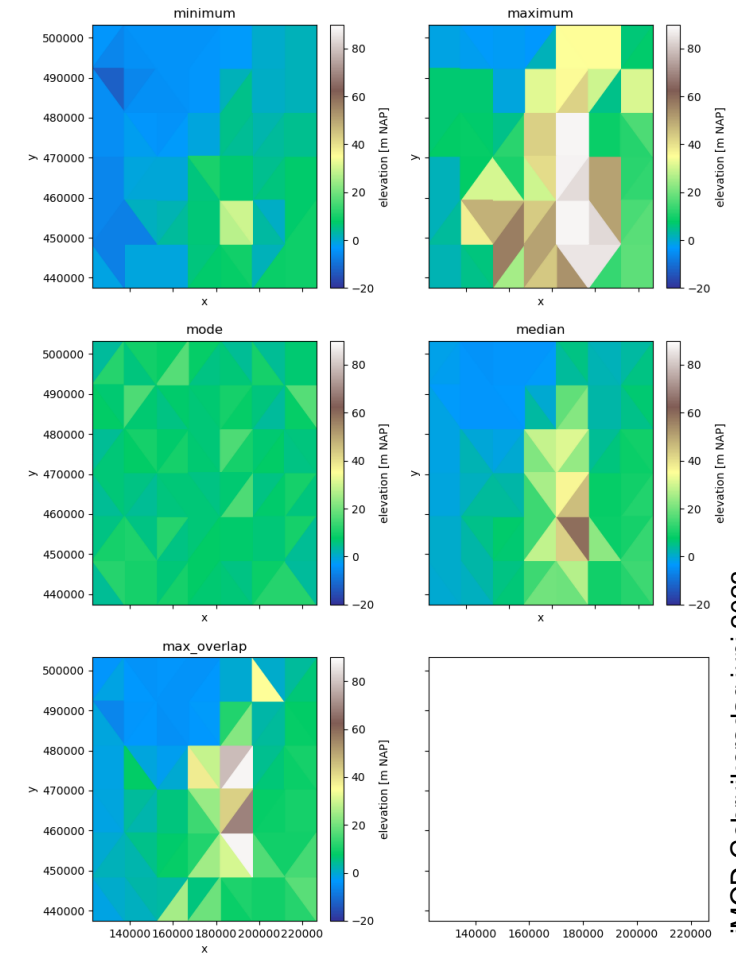
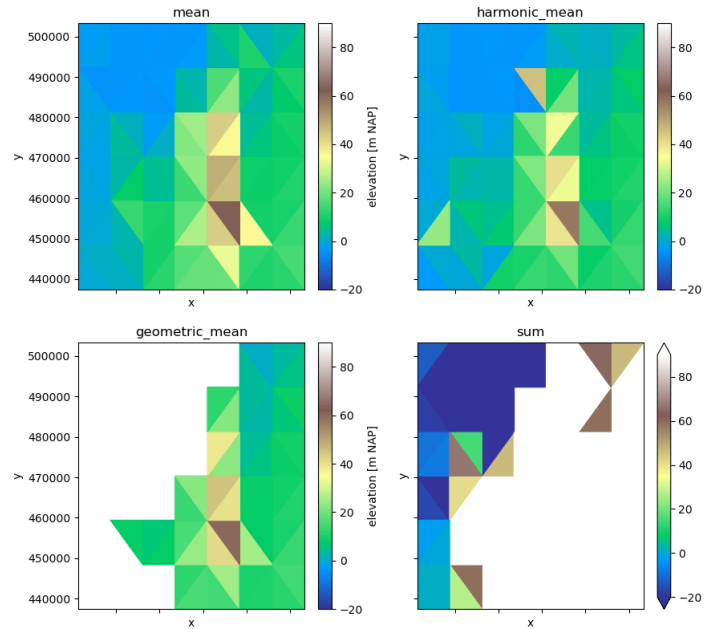
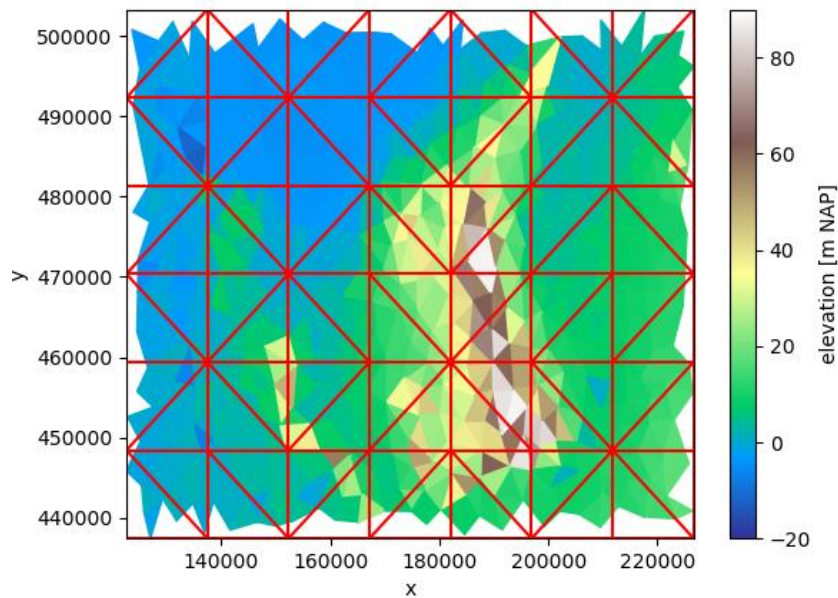
CentroidLocatorRegridder (“prikken”)



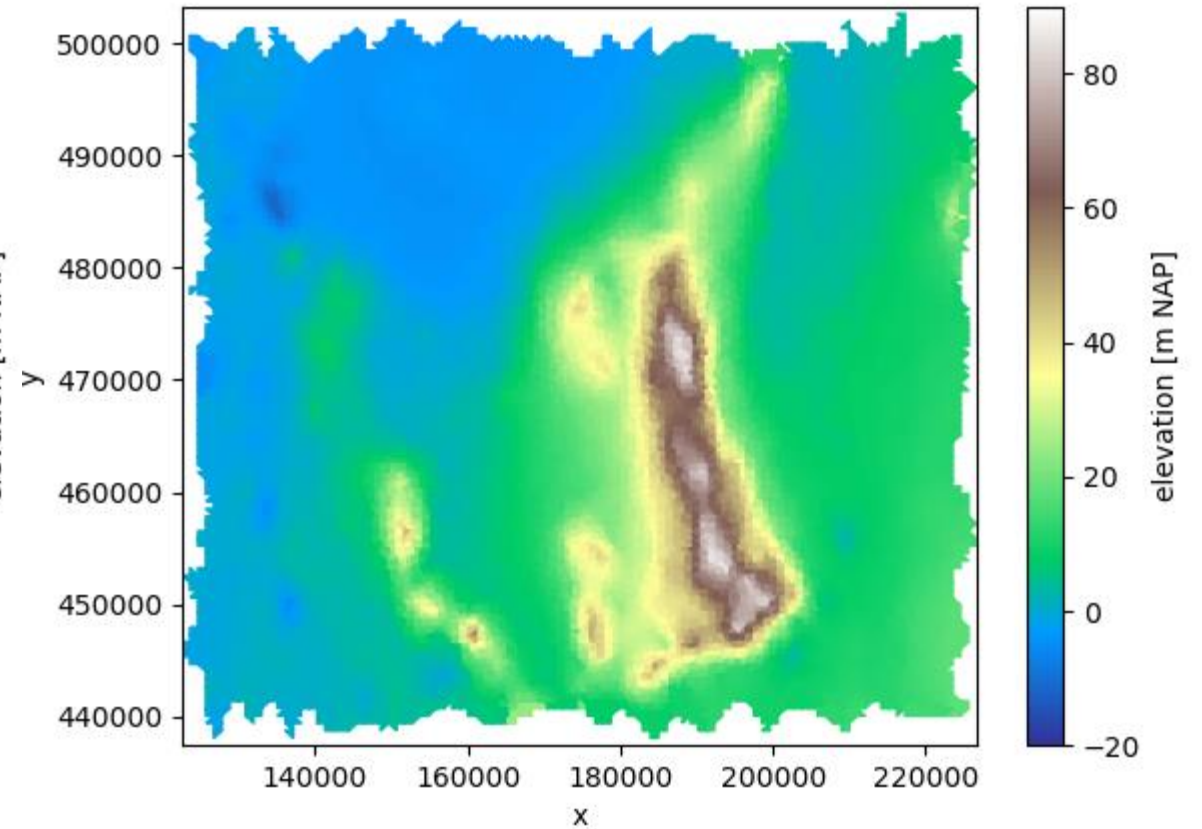
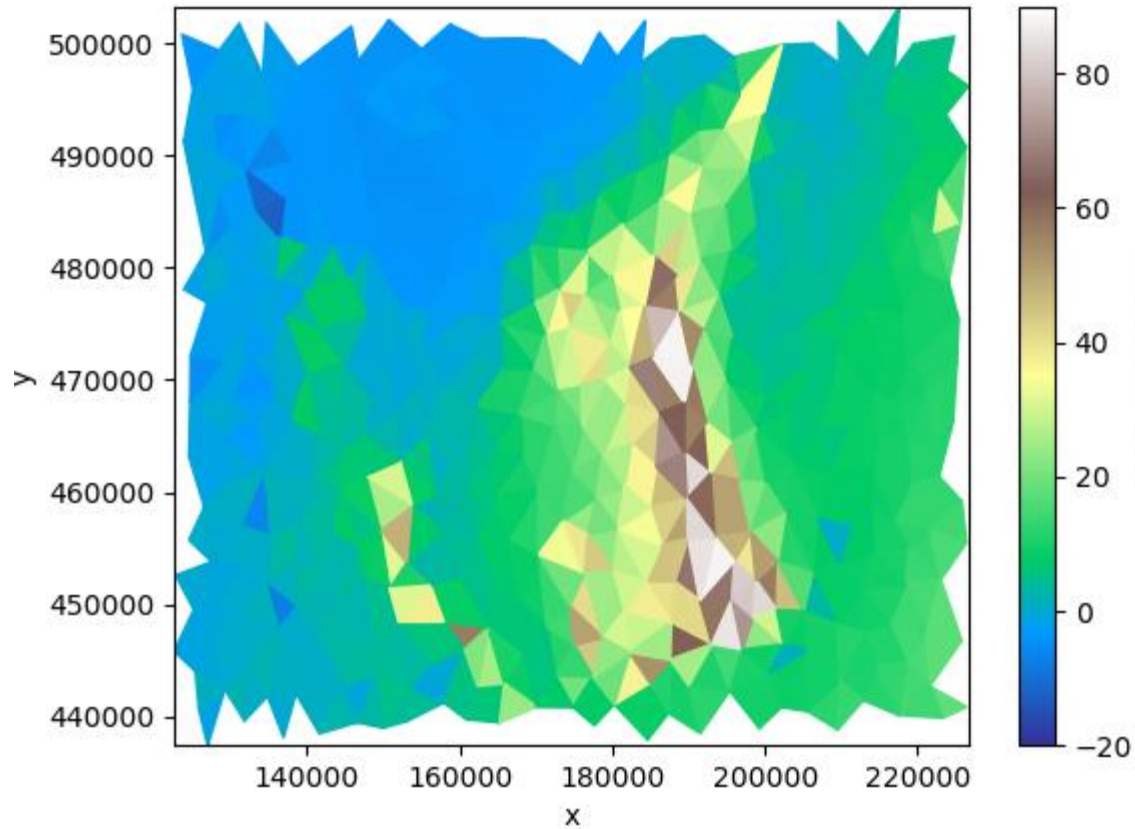
OverlapRegridder



OverlapRegridder: overzicht van methodes

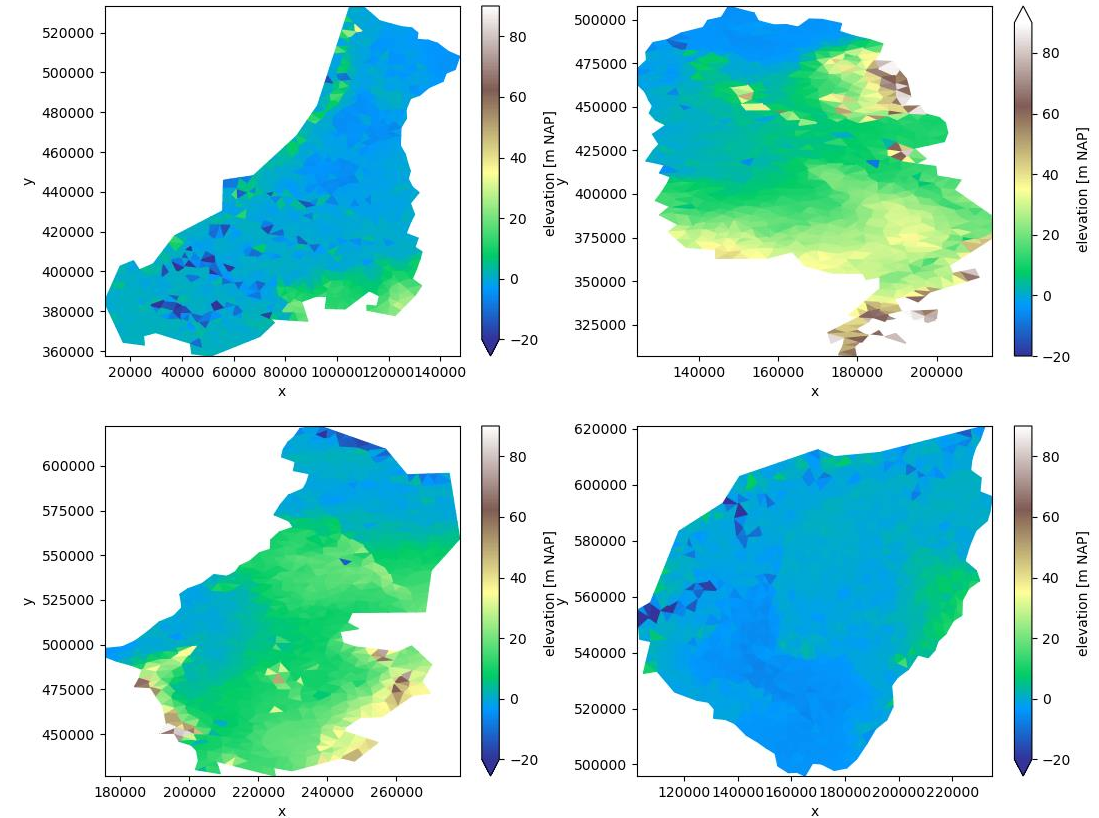
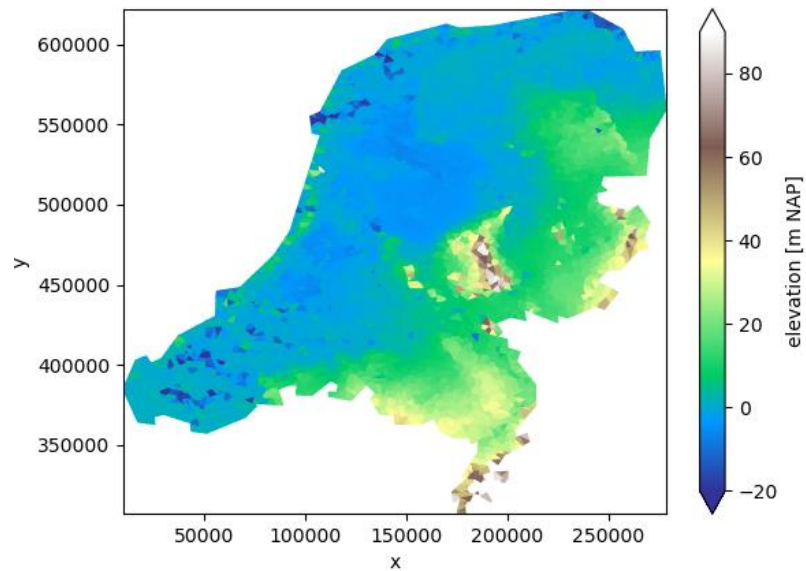


BarycentricInterpolator



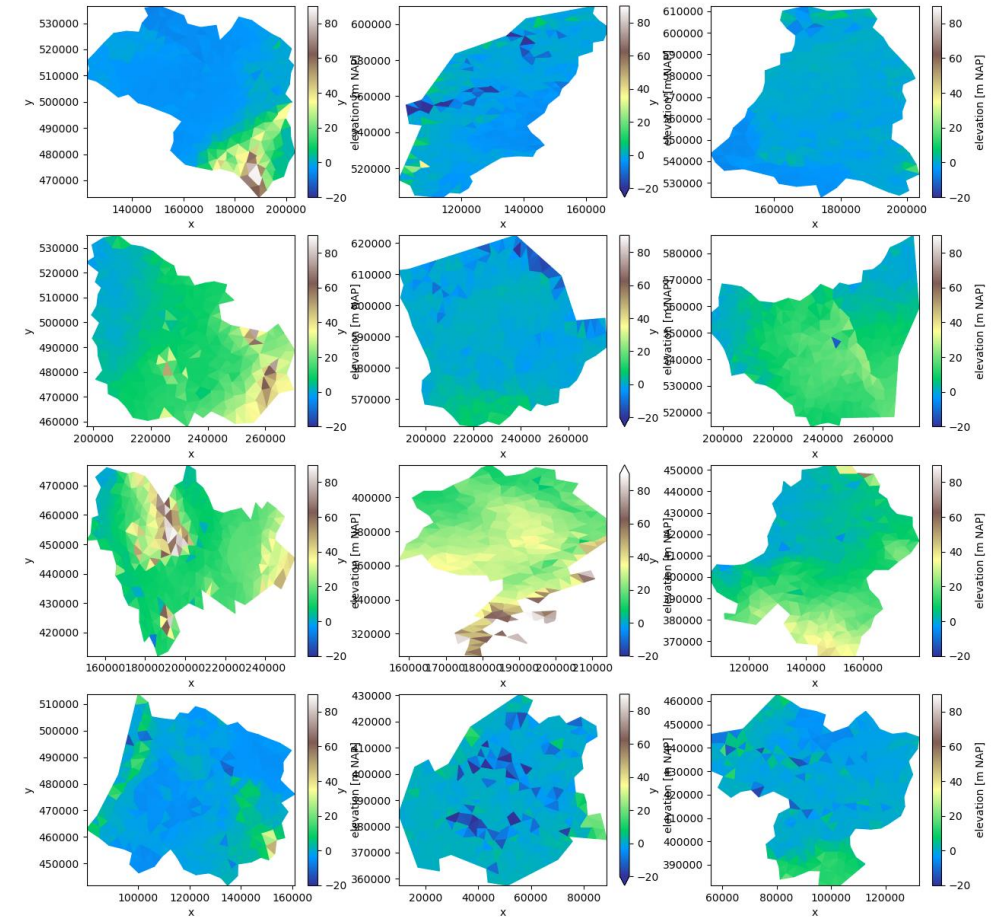
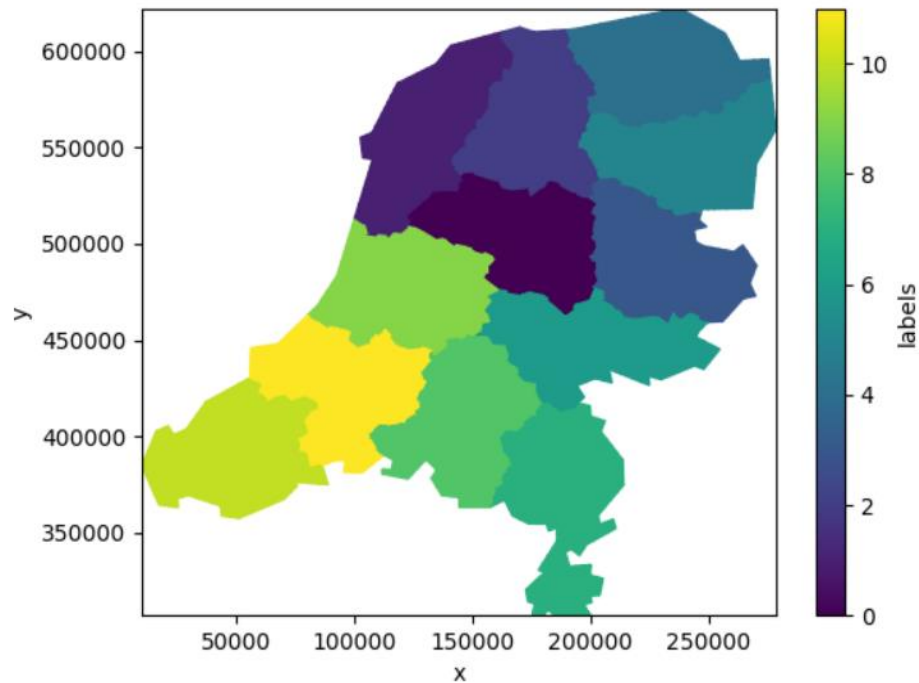
Partitionering (domein decompositie)

De release van parallelle MODFLOW6 komt dit jaar. Splitsen en weer mergen is geen onderdeel van MODFLOW6.



Partitionering

```
labels = uda.ugrid.grid.label_partitions(n_part=12)  
labels.ugrid.plot()
```



Dank u!

Maak een
ungestructureerd
grid



github.com/deltares/pandamesh
<https://deltares.github.io/pandamesh/>

Zet de data erop,
herschaaal
("IDFSCALE"), etc.



github.com/deltares/xugrid
<https://deltares.github.io/xugrid/>

Schrijf en lees
MODFLOW 6
bestanden



gitlab.com/deltares/imod/imod-python
<https://deltares.gitlab.io/imod/imod-python/>

Wat nu?

- Meerwaarde van ongestructureerde grids voor regionale toepassing moet nog blijken
- Gereedschappen bieden in ieder geval de mogelijkheid tot testen